National Synchrotron Light Source II
RSI Document No. 1.04.05.AB

Experimental Facilities Requirements, Specifications and Interfaces for the Ring Building and Experimental Floor.

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with help from Lino Miceli, Ove Dyling, and Nik Simos.

1 Contents

Identification

This document, NSLS-II Experimental Facilities Requirements, Specifications and Interfaces (RSI) for the Ring Building and Experimental Floor is a part of the documentation system, mapping to the NSLS-II project Work Breakdown Structure (WBS) and Cost Estimate Database (CED).

It captures and summarizes all requirements and specifications for the WBS elements within 1.04.05, User Instruments that relate to the Ring Building and Experimental Floor and describes all its technical interfaces with other WBS elements.

Compiled by	Signature	Date
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Document Updates

The **NSLS-II Experimental Facilities Requirements, Specifications and Interfaces (RSI) for the Ring Building and Experimental Floor** is a controlled document, revised under change control.

Revision number	Date	Authorized by	Changes made;
Version 1	May 23rd 2008	Andy Broadbent	Creation of new document by taking relevant sections from the Experimental Facilities Utilities RSI that relate to the Ring building and Experimental Floor.
Version 2	June 5th 2008	Andy Broadbent	Numerous comments from Nick Gmür.
Version 3	July 10th 2008	Andy Broadbent	Addition of note about SR tunnel roof, and handrail provisions. (Section 3.9).
Version 4	August 27th 2008	Andy Broadbent	Inclusion of comments from Andrew Ackerman, Nick Gmür and John Hill.
Version 5	November 22nd 2009	Andy Broadbent	Addition of Beamline Floor Territory guidelines section (3.6).
Version 6	August 4th 2010	Andy Broadbent	Addition of comments regarding VC-E criteria by Nick Simos.

Table 1 Revision Log

Acronyms and Abbreviations

ASD	Accelerator Systems Division
CED	Cost Estimate Database
CFD	Conventional Facilities Division
EPS	Equipment Protection System
FO	Fiber Optic
FOE	First Optics Enclosure
LOB	Laboratory Office Building
OM3	A type of high quality multimode fiber optic cable
PSS	Personnel Safety System
RSI	Requirements, Specifications, Interfaces
SR	Storage Ring
WBS	Work Breakdown Structure
XFD	Experimental Facilities Division

List of Tables

2 WHAT THIS DOCUMENT COVERS

This document covers the requirements on the NSLS-II Ring building and Experimental Floor that are NOT covered in the beamline utilities RSI (**insert link to this document later**).

The following requirements are covered in this document;

a. Building temperature and temperature stability;
b. Space provision for beamlines;
c. Long beamlines;
d. Beamline distribution on the experimental floor;
e. Experimental floor vibration;
f. EMI and RFI;
g. Acoustic noise;
h. Lighting;
i. Fire safety;
j. Emergency showers and eyewash;
k. Emergency sprinklers;
l. SR tunnel access;
m. SR tunnel interfaces.

The following are excluded (they are covered in the Beamline Utilities RSI);

a. Electrical power distribution;
b. Electrical grounding system;
c. De-ionized (process) water distribution;
d. Chilled water distribution;
e. Liquid nitrogen distribution;
f. Facility compressed gas (N2);
g. Experimental gases distribution;
h. Ambient temperature sensors;
i. Oxygen depletion sensors;
j. Communications;
k. Cabling and piping support structures;
l. Gas-exhaust system;
m. Air exchange system for forcing filtered experimental hall air into the hutch (this will then leak out via labyrinths and custom air outlets). The fans are mounted on the hutch roofs and air passes in through a vent labyrinth; the fans will be included in the hutch or cabin contracts and will be wired up under the beamlines utilities work package. This work is entirely covered by XFD budgets.
n. Special hazardous gas exhaust;
n. Local emergency lighting in and around hutches and cabins;

3 EXPERIMENTAL FACILITIES REQUIREMENTS FOR THE RING BUILDING AND EXPERIMENTAL FLOOR.

3.1 General

The Synchrotron Facility is designed to operate continuously 24 hours per day, 7 days per week (≥ 5,000 User Beam Hours per year). The design life of the building and experimental floor shall be a minimum of 30 years.

3.2 Temperature and Temperature Stability Requirements

The temperature of the experiment hall shall be set to the value shown in Table 2 Building Environmental Specifications. The temperature stability is <u>most important</u> at a particular point along the beamline, and over a period of 6-8 hours.
The stability specification shall be met with a varying thermal dissipation (to the air in the experiment hall) of up to 5kW per beamline.
Beamlines with extreme stability requirements may need "airlock doors" added to hutch entries in order to minimize temperature disturbances when hutches are opened and/or active temperature control units within the hutches.

Normal ambient conditions within the facility	
Temperature	75±1.8°F (24±1.0°C). See global parameter table. and 75±0.9°F (24±0.5°C) over a 1 hour period.
Relative humidity	50% ±10% in summer, and, 30% ±10% in winter.
Equipment to be capable of operation in the following adverse ambient conditions	
Temperature	50°F to 100°F (10-38°C)
Relative humidity	20% to 80%.

Table 2 Building Environmental Specifications

The environmental conditions are defined in Table 2 Building Environmental Specifications above. These conditions are defined more fully in the Conventional Facilities Requirements Document.

3.3 Space Provision for Beamlines

The beamlines to be installed on the synchrotron floor will be orientated in a direction tangential to the storage ring straights and bending magnets. The shield wall should be as close to the source points as possible, whilst providing space for necessary front end components. From the outside of the ratchet shield wall the beamline may be up to ~40m long before meeting the circumferential walkway.
The beamlines may include hutches of up to 5m height and a 2m clearance above should be allowed for workers and/or equipment before any constraints are met from building steelwork such as roof trusses etc.

3.4 Long Beamlines

Provision for long beamlines shall be made in the building design. It is anticipated that a minimum of three groups of three long beamlines may be installed. Each group of three beamlines shall consist of a lowβ – highβ – lowβ sequence since low beta sources are expected to be in greater demand for long beamlines with extreme focusing requirements.
The beamlines are required to cross the regular walkway and exit through the side of the building; the building cladding therefore needs to be easily removed, and replaced.
Each region of three long beamlines requires an external "bypass corridor" to allow the easy passage of personnel, carts, cryogen dewars etc. This bypass corridor shall be sunk below the experimental floor to provide the necessary headroom (~7 feet), and shall be approximately 8-10 feet wide; ramps are to be used at the ends, and small

equipment lifts are to be incorporated between beamlines where ramps are impractical due to maximum gradients constraints.

3.5 Beamline Distribution on the Experimental Floor

The distribution of beamlines on the experimental floor will be dictated by a combination of accelerator physics constraints (eg symmetry of damping wiggler installations, location of RF and injection straights, alternating high and low beta straights) as well as environmental constraints (lowest vibrations will probably be at points furthest from local roads), safety criteria (beamlines with continuous walls of hutches should not be placed adjacent to each other to avoid long "dead end" regions, and constraints imposed through the facility strategic plan.

This discussion is outside the scope of this document; the plans for beamline distribution will evolve over the next few years. Members of the XFD management team should be consulted for further information on this topic.

3.6 Beamline Floor Territory

The following guidelines shall be incorporated into the design of the floor.

- The egress aisle shall be of a width as defined in Section 3.11; Fire Safety.
- The egress aisle shall generally run parallel to the beamline that is immediately outboard (CCW), and offset by 1.5m for BM/TPW beamlines, and 2.0m for ID beamlines. Slight offsetting of the egress aisles will be required to align with the ratchet wall doors, as required, see below.
- Hutch access doors shall generally be on the outboard side.
- The egress aisles shall allow access to the 30 ratchet wall doors (ID FE access only).
- The BM FEs do not normally have access doors (the apertures are bricked up); hence the egress aisles do not need to align with the door locations and can end at the wall itself.
- A drawing (number LT-XF-CF-1008) defines the floor layout; variations from this drawing need to be agreed in writing with the XFD management team (a formal procedure is available at http://groups.nsls2.bnl.gov/ExperimentalFacilities/Utility/default.aspx under the "LOB and NSLS-II Experimental Hall" heading).

3.7 Vibration Criteria

The vibration criteria governing the experimental floor as well the experimental end-stations are a combination of requirements that reflect (a) the structural relationship between the experimental floor and the acceleration ring and the need to minimize both the spatial and temporal relative movements between locations (b) the need to ensure that the experimental floor as a whole complies with extremely sensitive facility guidelines and thus minimizes self-induced noise from experiment supporting systems.

In order to minimize the cultural noise that is expected to be generated by systems operating on the experimental floor in support of the experiments, criteria that are utilized by the various suppliers for systems that are being widely used in vibration-sensitive industries, i.e. microelectronics, nano-technologies, etc., will be used as guidance. Specifically, the generic vibration criteria expressed by the VC-E curve shown in figure 4.2.1.1 will be used. The criteria are based on the rms velocity of the experimental floor and it is expressed in terms of one-third octave band (proportional rather than fixed bandwidth) spectra. These generic criteria and their particular form work on the premise that the vibration at the NSLS II site and experimental floor is dominated by random broadband energy. While this is partially true, narrowband vibration sources on the experimental floor must be anticipated and isolated, thus allowing for narrowband based criteria to also apply.

The requirements of the adopted VC-E curve are anticipated to be achieved throughout the NSLS II experimental floor. Specifically, the VC-E curve calls for an rms velocity limit of 3.12 μm/s in the frequency band up to 80 Hz. It is envisioned that the strict requirements of the VC-E criteria curve will need to be satisfied in the vicinity of the sensitive NSLS II lines.

Given that the experimental end station stability is linked to the stability of the accelerator ring in the form of relative displacement (thus allowing sensitive experiments to be performed), the vibration stability criteria of the ring needs to also apply on the experimental floor. Specifically, to ensure that the uncorrelated ring floor motion is at levels that, when amplified as it propagates to the lattice, does not induce electron beam jitter that exceeds 0.3 microns (or 0.1 microns for a "stretched" goal), the floor rms vertical displacement for the frequency band between 4-100 Hz must remain below 25nm. At lower frequencies, where the motion is expected to be correlated, the rms displacement will be higher, but can be corrected with feed-back. Vibration measurements at the NSLS II site indicate that the rms value of the background vibration for the frequency band of 1-4 Hz is ~70nm (average). This of course will be filtered by the structure (monolithic ring/experimental floor) and be reduced significantly.

In adopting the same narrowband-based criteria for the experimental floor, it should be required that experimental stations and components do not induce vibrations that lead to vertical rms displacements on the floor exceeding 25nm for the frequency range of 4-100 Hz. Further, care should be taken so experimental station structures and components have their fundamental frequencies >> 4 Hz. This should be accomplished by ensuring that structures/components supported on the experimental floor are either rigidly fixed or they are isolated.

In an effort to ensure that the two (2) criteria can work harmoniously on the NSLS II floor (i.e. VC-E curve to help guide systems provided by suppliers, and narrow-band to control the sensitive experimental lines and their relation with the accelerator ring), measurements were performed on the experimental floor of an operating light source. As Figures 4.2.1.2 and 4.2.1.3 indicate, it is possible for a facility to meet both criteria. It should be expected that both criteria can be met over the section of the NSLS II supporting the most sensitive beamlines.

Further details of the governing criteria and of the experimental floor performance are included in the technical note "*NSLS II Experimental Facilities Vibration Stability,"* [Ref. A]

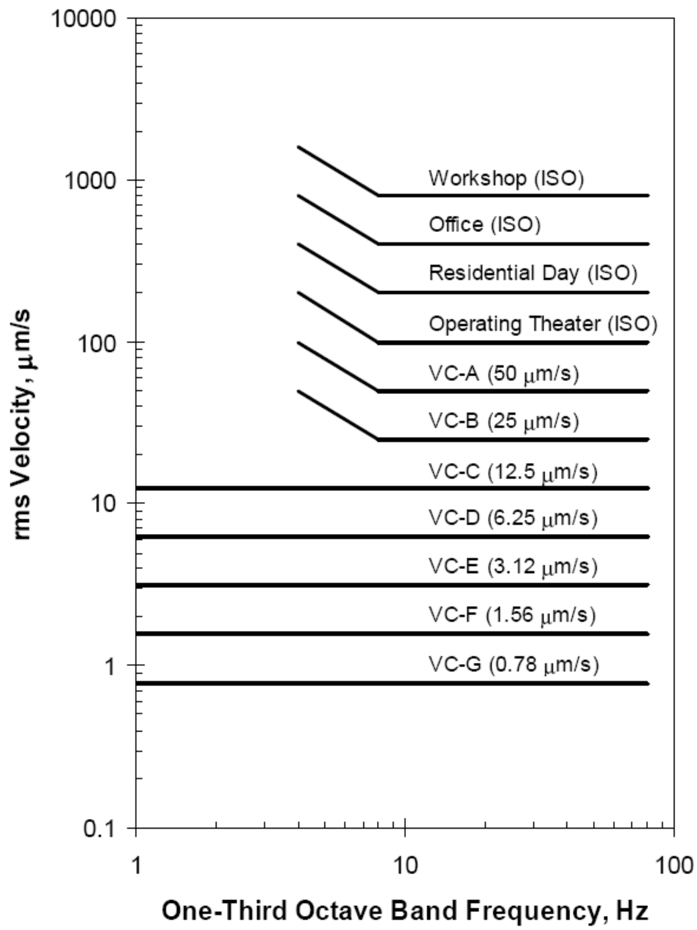

Figure 4.2.1.1: Vibration Criteria (VC) Curves for Vibration-sensitive Equipment

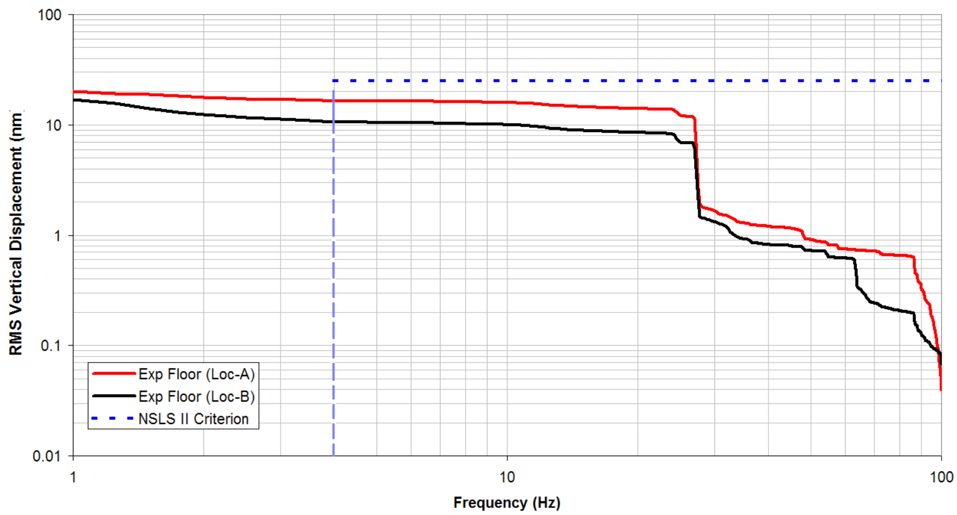

Figure 4.2.1.2: Narrowband vibration criteria for the NSLS II ring (< 25 nm rms for 4-100 Hz frequency band) and performance of the experimental floor of an operating light source

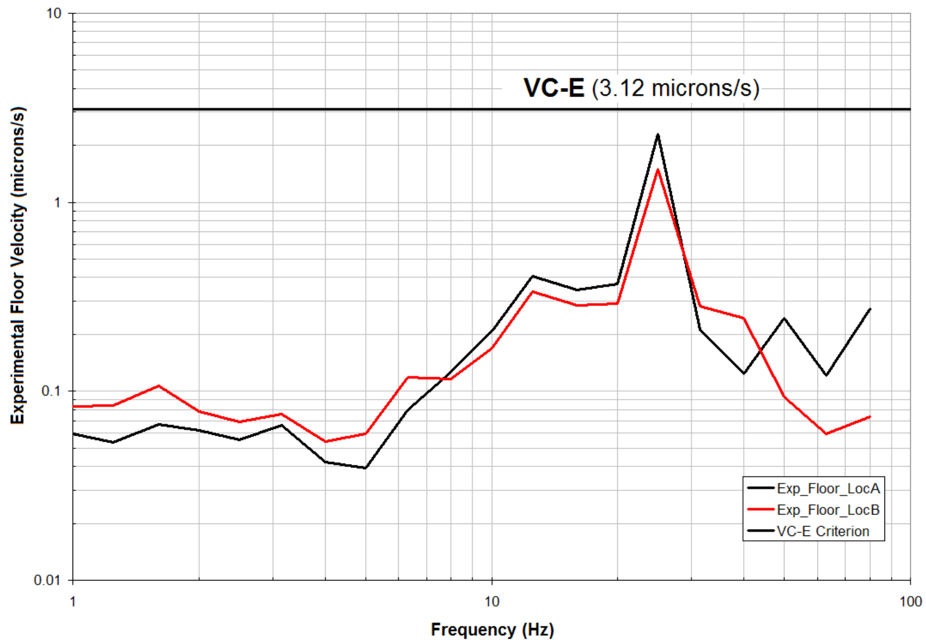

Figure 4.2.1.3: VC-E criterion and one-third octave velocity band data obtained on the experimental floor of an operating light source facility

3.8 EMI and RFI

Careful consideration shall be made in the specification of any equipment for the minimization of Electromagnetic Interference and Radio Frequency Interference. Sensitive measurements will be made at the synchrotron and these are easily degraded by such interference.

3.9 Acoustic Noise

All possible measures should be taken to keep the acoustic noise levels to a minimum. This is important for two reasons; maintaining a pleasant working environment for the Users, and reduction of vibrations levels for sensitive equipment (particularly on the infra red beamline).

Noise typically comes from a range of sources;

- Power supply and computer fans
- Water flow in pipes
- Air flow in ducts
- Rotary pumps (generally discouraged except for initial roughing and leak detection).

Experience has shown that a noise level of 60dBA is too high for comfortable prolonged working on a synchrotron floor. Since it is unlikely that all beamlines will have operator cabins this ambient noise level is very important.

The noise level with the accelerator running, but without any contribution from the beamlines equipment, is specified at <55dBA (see Conventional Facilities Functional Requirements Document). The following requirements are established to minimize noise produced by the beamlines;

- Careful specification of processors and video cards in stand alone computers for minimum power consumption, heat generation, and therefore fan cooling.

- Use of chilled water for the cooling of enclosed electronics racks (keeping fans to a minimum, and fully enclosed).
- Water flows must be designed to be a maximum of 2m/s (6 ft/sec) except inside components where demanded by the specific design of such a component.
- Careful specification of other equipment, eg chillers, compressors etc. and inclusion of sound damping materials.
- Whisper-type fans must be used.
- Inclusion of noise performance criteria in the specifications for all components.
- A generic sound level specification for all equipment with exception approval requirement built into the purchasing system.

3.10 Lighting

The design of the building shall provide adequate lighting for the performing of detailed tasks at any point on the experiment floor. Natural light is highly desirable, but solar gain must be avoided. It is expected that a lighting level of 100-200 foot candles would be adequate, particularly when supplemented by task lighting provided as part of the User area fitout.

3.11 Fire Safety

The emergency fire egress requirements have been documented in a number of memos by Nick Gmur on sharepoint;
http://groups.nsls2.bnl.gov/eshqa/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2feshqa%2fShared%20Documents%2fESH%20Program%20Documents%2fBeamline%20Safety%20and%20Life%20Safety%20Discussions&FolderCTID=&View=%7bDCEBD175%2d88FE%2d4F8A%2dBE9A%2dF741DA69C56E%7d

The summary from this is that beamlines should, wherever possible, have a gap between the FOE and experimental stations in order to give personnel a choice of exit route in the event of an emergency. A duck under is permissible within the first 60 feet.

The egress aisle between beamlines shall be 1m wide (see above link, minutes of meeting on April 3rd).

The building shall be constructed to relevant State and Federal codes to give the required fire ratings.

A 10’ wide walkway around the facility shall be provided for fire egress and the distribution of people and equipment. Note: the bypass corridor width is 8’ wide.

The capability for connection to the building fire alarm system (eg from smoke sensors in a beamline hutch) shall be provided.

3.12 Emergency Shower and Eyewash

A tepid water system shall be provided around the facility on the inside of the outer wall adjacent to the access corridor to allow for emergency eyewash / shower stations to be added as required. This pipe shall be fitted with dual “T”s and an isolation valve between, at a maximum of 50’ intervals to permit a flowing loop to be incorporated in series without system shutdown. The main water pipe, valves, “T”s and blanks are the responsibility of CFD. The addition of the eyewash / showers will be the responsibility of XFD.

3.13 Emergency Sprinklers

A flow and return "stub" for connection to the fire sprinkler system shall be provided adjacent to the beamlines, above the SR tunnel roof. See the "NSLS-II Fire Hazards Analysis Document".

3.14 SR Tunnel Roof Access

Provision is required for personnel access to the roof of the SR tunnel since this is the primary means of accessing the hutch roofs (where beamline electronics racks will be located). Steps from the experimental floor up onto the SR tunnel roof shall be provided at convenient locations.

3.15 SR Tunnel Roof Interfaces

The SR tunnel and roof will be of a concrete construction and completed early in the project cycle. Hutches will then have to interface correctly (ie with no gaps) to the completed tunnel. It is envisaged that laser tracker type surveys will be required of the completed tunnel and floor so that hutch panels may be custom shaped to suit.

The handrails on the SR tunnel roof do not require any provision for hutch / beamline addition. Handrails will be cut and steps down onto the hutch roof will be added as, and when, required.

3.16 Provision for LOBs

Laboratory Office Buildings (LOBs) will be located around the periphery of the synchrotron building, at five discrete points (the long beamlines can pass in the gaps between these LOBs). Provision shall be included in the building design for these LOBs to be easily added later without excessive noise, dust, or temperature fluctuations.

Interfaces with the CFD

WBS	Title	Dictionary Definition
1.05.02	Conventional Facilities Engineering and Design	Execution of engineering and design of NSLS-II buildings, utilities, and improvements to land by developing design requirements, preparing design drawings and specifications for construction contracts, and providing engineering support during the construction phase, to assure proper execution of the design and complete as-built documentation.
1.05.03	Conventional Facilities Construction	Construction of all NSLS-II buildings, utilities, and improvements to land, performed by multiple contractors and managed with the assistance of a Construction Management firm.

Table 3 Interfaces of WBS element 1.04.01.02, XFD Utilities with the CFD (WBS 1.05)

3.18 Interfaces with ESS&H

WBS	Title	Dictionary Definition
1.01.02	Environmental, Safety and Health	This function provides support for ESH & training related activities associated with the NSLS-II R&D program, the NSLS-II construction program, and the NSLS-II commissioning activities. It includes ESH support and oversight for all ESH issues including radiation, industrial hygiene, general safety, construction safety and training.
1.01.02.01	ESH Management	This function provides ESH management for safety & training related activities associated with the NSLS-II R&D program, the NSLS-II construction program, and the NSLS-II commissioning activities. It specifically includes: 1. Preparation of ESH manuals, procedures, etc. 2. Providing support and guidance to NSLS-II staff regarding ESH and training requirements 3. Conducting safety evaluations of design to ensure compliance with DOE and BNL ESH requirements 4. Monitoring workplace activities and conditions to ensure compliance w/ DOE & BNL ESH . Determination of ESH related training requirements,tracking training compliance, and provision of NSLS-II ESH training for staff members. 6. Preparation of safety assessment documents needed to support CD-1, 2, 3, & 4. 7. Coordination and follow up of required ESH reviews associated with beneficial occupancy and Accelerator Readiness Reviews.
		The installation of beamline utilities raises safety issues: electrical, high-pressure gases, etc. Compliance to safety regulation requires coordination w/ ESS&H.

Table 4 Interfaces of WBS element 1.04.01.02, XFD Utilities with ES&H (WBS 1.01.02)